





POLICY PAPER

Tackling the Risk of a Future EU Energy Crisis in Critical Raw Materials?

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TACKLING THE RISK OF A FUTURE EU ENERGY CRISIS IN CRITICAL RAW MATERIALS?

Background

Since the beginning of the last decade, the amount of energy produced in the European Union has decreased, in particular with respect to solid fossil fuels, natural gas, and oil and petroleum products, whereas renewable sources have been increasing their share in the production of energy. The general reduction trend in energy production caused an increase in imports from non-EU countries in order to satisfy the EU member states' energy needs.¹

Each member state has developed its import relations with non-EU countries. However, when considering the conglomerate European Union, the main partner is Russia, which has been for a long time the major supplier of natural gas, oil and solid fossil fuels. Besides, for some EU member states, Russia is the only supplier or primary supplier among few alternatives.² This translates into a dependency of the EU on a single supplier of energy sources.

Being dependent on a single supplier creates issues from the energy security perspective. Recently, this problem has been highlighted by an energy crisis, which according to the Executive Director of the International Energy Agency, Fatih Birol, "the world has never witnessed [before] in terms of its depth and its complexity".³ The "danger of being too dependent on commodities"⁴ from a single provider became particularly relevant with the war in Ukraine that started on February 2022, and the consequent impact on relations between the EU, its member states and Russia which eventually involved the energy sphere.

In a response to the international situation, in May 2022 the European Commission designed the REPowerEU plan, which aims at reducing the dependence of the European Union and its member states on the imports of fossil fuels from Russia by diversifying suppliers and emphasizing the use of clean energy sources in order to create a "more resilient energy system and a true Energy Union."

The REPowerEU plan goal to foster the renewable role in the energy mix, hence advancing the green transition of the economy, is in line with the commitment taken by the EU and its member states together with other international actors through the Paris Agreement adopted in 2015 which entails efforts to combat climate change.⁵ Additionally, it is an advancement on the roadmap established by the European Green Deal announced in 2019, which calls for the transition to a clean and circular economy to ensure the efficient use of resources⁶ and aims at being climate neutral in 2050.⁷

In order to support the green transition, it is necessary to secure the supply of energy sources, especially materials and technologies used to produce renewable energy. In particular, attention has to be given to what the EU has classified as critical raw materials. Hence it is relevant to ask how

¹ Eurostat Statistics Explained. (2022). *Energy statistics - an overview*. https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Energy_statistics_-_an_overview#Primary_energy_production

² The reference is to the situation of dependency of the EU before the recent international developments.

³ Macdonald-Smith, A. (2021). This is the 'first global energy crisis' and it will get worse. *Financial Review*. <https://www.afr.com/policy/energy-and-climate/worst-still-to-come-on-energy-crunch-iea-s-birol-20220711-p5b0md>

⁴ Jens Stoltenberg's speech is available at NATO. (2022). *Opening speech by NATO Secretary General Jens Stoltenberg at the High-Level Dialogue on Climate and Security, NATO Public Forum*. https://www.nato.int/cps/fr/natohq/opinions_197168.htm

⁵ United Nations Climate Change. (n.d.) *The Paris Agreement*. https://unfccc.int/process-and-meetings/the-paris-agreement/the-paris-agreement?gclid=Cj0KQCjw-fmZBhDtARIsAH6H8qgdo7BXESxb9cE6pPORF1tR2FgwdaLRhcfEHELmIUQLKH23bb6XN7YaAtsiEALw_wcB

⁶ European Commission (2019). *The European Green Deal sets out how to make Europe the first climate-neutral continent by 2050, boosting the economy, improving people's health and quality of life, caring for nature, and leaving no one behind*. https://ec.europa.eu/commission/presscorner/detail/en/ip_19_6691

⁷ European Commission. (2019). *Communication from the Commission to the European Parliament, the European Council, the Council, the European Economic and Social Committee and the Committee of the Regions the European Green Deal* COM/2019/640 final

TACKLING THE RISK OF A FUTURE EU ENERGY CRISIS IN CRITICAL RAW MATERIALS?

the EU can ensure a reliable, secure and continuous supply of these materials in order to avoid a future energy crisis.

Current State of Play

1. The European Union and the green energy transition

The European Union has already taken steps towards the modernisation and transformation of the economy with the final aim to be climate neutral by 2050. Throughout the last decades, renewable sources steadily increased their share in the gross final energy consumption passing from about 9% in 2004 to 22.1% in 2020.

With respect to gross electricity consumption, renewables counted for 37.5%. The primary renewable energy sources utilised were wind (36%) and hydropower (33%), followed by solar power (14%), which is the fastest-growing source. In addition, renewable sources have been on the rise with respect to the total energy use for heating and cooling increasing from 11.7% in 2004 to 23.1% in 2020, whereas in transport renewable sources increased by about 9 percentage points between 2004 and 2020, when it reached the set target of 10%.⁸

However, the clean energy transition gained momentum with the worsening energy crisis aggravated by the war in Ukraine. The higher energy prices and the energy security concerns raised by the over-dependence on imports of fossil fuels from Russia, in particular natural gas, represented a turning point for the clean energy transition.

In this context, the REPowerEU plan has the objective of tackling the high dependence of the member states of the European Union on imports of fossil fuels from Russia through a combination of measures such as diversifying suppliers, accelerating employment and scaling up the use of clean energy sources, reducing energy consumption through energy saving and efficiency.⁹

Given the significant role of renewable energy sources in the REPowerEU plan, it is necessary to consider the EU trade in products related to green energy. Since 2015 the import of green energy-related products has increased. With respect to trade partners, the country from which the majority of the European Union imports originate is China. In 2020 the EU imported from China 84% of its wind energy-related products, 75% of its solar energy-related products, and 27% of its liquid biofuels.¹⁰

Moreover, with respect to clean energy production another aspect to consider is the role of critical raw materials (CRMs). In 2020 the European Commission classified 30 raw materials¹¹ according to their significance for the European economy -green and digital transition, defence-related technology, and medical-related technology-, and according to the risks level related to the

⁸ Eurostat statistics explained. (2022). Renewable energy statistics. https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Renewable_energy_statistics#Share_of_renewable_energy_more_than_doubled_between_2004_and_2020

⁹ European Commission. (2022). *Communication from the Commission to the European Parliament, the European Council, the Council, the European Economic and Social Committee and the Committee of the Regions Repowereu Plan* COM/2022/230 final

¹⁰ Eurostat statistics explained. (2021). International trade in products related to green energy. https://ec.europa.eu/eurostat/statistics-explained/index.php?title=International_trade_in_products_related_to_green_energy

¹¹ List of CRMs in alphabetical order: Antimony, Baryte, Bauxite, Beryllium, Bismuth, Borate, Cobalt, Coking Coal, Fluorspar, Gallium, Germanium, Hafnium, Heavy Rare Earth Elements, Indium, lithium, Light Rare Earth Elements, Magnesium, Natural Graphite, Natural Rubber, Niobium, Platinum Group Metals, Phosphate rock, Phosphorus, Scandium, Silicon metal, Strontium, Tantalum, Titanium, Tungsten, Vanadium. List according to the revised one presented in European Commission (2020). *Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions Critical Raw Materials Resilience: Charting a Path towards greater Security and Sustainability* COM/2020/474 fina

TACKLING THE RISK OF A FUTURE EU ENERGY CRISIS IN CRITICAL RAW MATERIALS?

interruptions in their supply.¹² Among these materials rare earth elements (REEs) are fundamental in several high-technology products and green-related technology, including wind turbine magnets, solar cells, and cells used in electric vehicles.¹³

2. The predominant role of China in the supply chain of critical raw materials

There are some countries that have a primary role in the supply of specific CRMs. For instance, the EU imports 98% of Borates and 62% of Antimony from Turkey, 68% of Cobalt from the Democratic Republic of Congo, 71% of Phosphorus from Kazakhstan, and it imports several CRMs from China, among them 93% of Magnesium, 49% of Bismuth, and a significant 98% of rare earth elements. REEs are seventeen chemical elements¹⁴ which are abundant but unevenly distributed around the world. In addition, they can be found in low concentrations and not in pure forms but within other minerals, which higher the costs of their extraction and refinery process, hence overall exploitation.¹⁵ Therefore, REEs reserves are considered particularly valuable and, most importantly, strategic.

The strategic significance of these resources was recognized by Deng Xiaoping in 1992 during his Southern Tour through the statement: “the Middle East has oil, China has rare earths”.¹⁶ Indeed, China has the highest reserves amounting to an estimated 44 million tonnes, followed by Vietnam (22 million tonnes) and Brazil (21 million tonnes).¹⁷ Therefore, driven by a long-term perspective and strategic concept China endorsed several policies with the final aim of exploiting the country’s wealth in REEs and other raw materials while collocating the country in a position of strength in all CRMs’ supply chains.¹⁸ China is the leading producer of REEs at a calculated 168 thousand tonnes in 2021, whereas the second and third largest producers are the US (43 thousand tonnes) and Myanmar (26 thousand tonnes).¹⁹

Furthermore, in 2021 the China Rare Earth Group was created as a product of a merger among five Chinese enterprises.²⁰ The China Rare Earth Group accounts for 30% of China’s total REEs

¹² EU SCIENCE HUB Raw Material Information System (2020). *CRM list 2020*. European Commission. <https://rmis.jrc.ec.europa.eu/?page=crm-list-2020-e294f6>

¹³ Gupta, S., (2021). Rare earth metals are used extensively in clean energy technologies. But how safe are they? *Down to Earth*. <https://www.downtoearth.org.in/blog/waste/rare-earth-metals-are-used-extensively-in-clean-energy-technologies-but-how-safe-are-they--75111>

¹⁴ Rare earth elements are composed by fifteen lanthanides, scandium, and yttrium. The fifteen lanthanides are lanthanum, cerium, praseodymium, neodymium, promethium, samarium, europium, gadolinium, terbium, dysprosium, holmium, erbium, thulium, ytterbium, and lutetium.

¹⁵ Gupta, S., (2021). Rare earth metals are used extensively in clean energy technologies. But how safe are they? *Down to Earth*. <https://www.downtoearth.org.in/blog/waste/rare-earth-metals-are-used-extensively-in-clean-energy-technologies-but-how-safe-are-they--75111>

¹⁶ Chu, D., L., (2010). Seventeen Metals: “The Middle East has oil, China has rare earth”. *Insider*. <https://www.businessinsider.com/seventeen-metals-the-middle-east-has-oil-china-has-rare-earth-2011-1?r=US&IR=T>

¹⁷ National Minerals Information Center. (n.d.). *Rare Earths Statistics and Information*. USGS science for a changing world. <https://www.usgs.gov/centers/national-minerals-information-center/rare-earths-statistics-and-information>

¹⁸ Umbach, F., (2022). Critical Raw Materials for the energy transition: Europe must start mining again. *Energypost.eu*. <https://energypost.eu/critical-raw-materials-for-the-energy-transition-europe-must-start-mining-again/>

¹⁹ National Minerals Information Center. (n.d.). *Rare Earths Statistics and Information*. USGS science for a changing world. <https://www.usgs.gov/centers/national-minerals-information-center/rare-earths-statistics-and-information>

²⁰ The companies interested in the merger are Minmetals Rare Earth, Chinalco Rare Earth & Metals, and China Southern Rare Earth Group, Ganzhou Zhonglan Rare Earth New Material Technology and Jiangxi Ganzhou Rare Metal Exchange. In Chang, F., K., (2022). China's Rare Earth Metals Consolidation and Market Power. Foreign Policy Research Institute <https://www.fpri.org/article/2022/03/chinas-rare-earth-metals-consolidation-and-market-power/#:~:text=What%27s%20more%2C%20in%20December%202021,Earth%20New%20Material%20Technology%20and>

TACKLING THE RISK OF A FUTURE EU ENERGY CRISIS IN CRITICAL RAW MATERIALS?

production, and it is the world's second-largest producer.²¹ This decision is part of a broader goal of gaining greater control over the price of REEs. Indeed, given the predominant role of China in their production, the aim is to increase the bargaining power during price negotiations by taking advantage of the reduced competition among companies.²²

Moreover, China is interested in preserving its predominant role in CRMs value chain by securing mining deals with African countries, as well as countries in Latin America and in Asia. An example is the deal between the Chinese company Ningbo Zhoushan and the Brazilian mining company Vale on bringing iron ore to China for processing.²³ In addition, China imported more than 140 thousand tonnes of REEs from the third world's largest producer, Myanmar, between 2017 and 2021.²⁴

The result of the Chinese efforts in the last three decades in establishing China as a dominant player in the whole value chain of CRMs is the country's primary role as a trade partner for other international players, whose imports rely on Chinese companies or Chinese presence in joint ventures, and projects abroad. For instance, considering REEs, the United States imports from China accounted for 78% in the period 2017-2020, Japanese imports in 2020 accounted for about 58% following two decades of reduction from a dependency of 90%, and Europe has a significant dependence on imports of REEs from China of about 98%.

To have a further understanding of the relevance of CRMs and in particular of REEs, it is useful to recall that in 2010 China suspended exports of REEs to Japan as a consequence of diplomatic conflicts spurred in the context of their dispute on maritime territories in the East China Sea.²⁵ Additionally, in 2019 China was considering restricting exports of REEs to the United States as a consequence of the escalating trade conflict.²⁶

Another example of the predominant role of China in the CRMs supply chain is lithium, which is fundamental to producing batteries for several applications, among them electric vehicles. China accounts for about 60% of the world's refining processes of lithium, 77% of the world's battery cell capacity, and 60% of global component manufacturing.²⁷ China is the third producer of lithium worldwide after Australia and Chile.²⁸

In addition, Chinese companies hold assets in lithium resources in other countries. For instance, the Tianqi Lithium Corporation has resources and production assets in Australia and Chile²⁹ and the

²¹ Chang, F., K., (2022). China's Rare Earth Metals Consolidation and Market Power. *Foreign Policy Research Institute* <https://www.fpri.org/article/2022/03/chinas-rare-earth-metals-consolidation-and-market-power/#:~:text=What%27s%20more%2C%20in%20December%202021,Earth%20New%20Material%20Technology%20and>

²² Ibidem.

²³ Cohen, A., (2022). China And Russia Make Critical Mineral Grabs in Africa While the U.S. Snoozes. *Forbes*. <https://www.forbes.com/sites/arielcohen/2022/01/13/china-and-russia-make-critical-mineral-grabs-in-africa-while-the-us-snoozes/>

²⁴ Radio Free Asia. (2022). China-led rare earth mining in Myanmar fuels rights abuses, pollution: report. *Radio Free Asia*. <https://www.rfa.org/english/news/myanmar/rareearths-08092022183340.html>

²⁵ Bradsher, K., (2010). Amid Tension, China Blocks Vital Exports to Japan. *The New York Times* <https://nytimes.com/2010/09/23/business/global/23rare.html>

²⁶ Shen, M., Zhang, M., (May 2019). China considers U.S. rare earth export curbs. *Reuters*. <https://www.reuters.com/article/us-china-usa-rareearth-idUSKCN1SY1GK>

²⁷ Root, A., (2022). China Is Winning the Lithium Wars. What It Means for Tesla and Other EV Stocks. *Barron's*. <https://www.barrons.com/articles/china-ev-batteries-lithium-mining-51652889888>

²⁸ Statista. (2022). *Major countries in worldwide lithium mine production in 2021*. <https://www.statista.com/statistics/268789/countires-with-the-largest-production-output-of-lithium/>

²⁹ Skidmore, Z., (2021). Top 5 largest lithium mining companies in the world. *Mining Technology*. <https://www.mining-technology.com/analysis/top-5-largest-lithium-companies/>

Jiangxi Ganfeng Lithium Group holds assets in Australia, Argentina, Mexico, Mali, and Ireland.³⁰ In the last decade, the Chinese government invested in the supply chain of lithium by assisting companies in building out lithium mining and refining infrastructure in order to support the production of electric vehicles, raising the domestic demand for lithium batteries.³¹ The Chinese presence abroad serves the purpose of ensuring lithium supplies for the Chinese domestic market while avoiding or reducing reliance on external suppliers, and it also guarantees that China is present in the whole supply chain, hence foreign countries will have to pass at least once under a Chinese controlled phase of the supply chain.

In addition, cobalt is utilized to reinforce the stability of lithium-ion batteries and China accounts for approximately 85% of the refined supplies, while Chinese companies control about 70% of the mining sector in the Democratic Republic of Congo, which is the main producer of cobalt.³²

3. The European Union and critical raw materials

The importance of CRMs in the advancement of the economy has been known for years and the risks of a dependency on raw materials were already mentioned in 2018 by the former European Commission Vice-President for the Energy Union and EU Space Policy, Maroš Šefčovič, when he stated that considering “the issue of dependency, [the European Union] could end up in a situation where raw materials become the new oil”.³³ In addition, the present-day international situation reminds us of the essential role that a secure supply of energy sources and products has in our economies and this is especially relevant with respect to CRMs.

In order to address the issue of ensuring the supply of raw materials, in 2008 the EU adopted the *raw materials initiative*,³⁴ which is based on three pillars: 1) fair and sustainable supply of raw materials from global markets. The aim is to pursue raw material diplomacy which entails engaging with third countries through strategic partnership and policy dialogue;³⁵ 2) sustainable supply of raw materials to promote and strengthen the mining industry within the EU while taking into account social, environmental and economic aspects;³⁶ 3) resource efficiency and supply of 'secondary raw materials' through recycling to support research and innovation and to promote economic incentives for reuse and recycling.³⁷ The *raw materials initiative* was reinforced in 2010

³⁰ Go, J., (2022). Chinese companies expanding footprint in global lithium mines. *FDI Intelligence*. <https://www.fdiintelligence.com/content/feature/chinese-companies-expanding-footprint-in-global-lithium-mines-81261>

³¹ OneCharge. (2022). How China came to dominate the market for lithium batteries and why the U.S. cannot copy their model. *OneCharge*. <https://www.onecharge.biz/blog/how-china-came-to-dominate-the-market-for-lithium-batteries-and-why-the-u-s-cannot-copy-their-model/>

³² Pattison, Pete., Firdaus, F., (2021). ‘Battery arms race’: how China has monopolised the electric vehicle industry. *The Guardian*. <https://www.theguardian.com/global-development/2021/nov/25/battery-arms-race-how-china-has-monopolised-the-electric-vehicle-industry>

³³ Simon, F., (2018). EU’s Šefčovič: Real risk that ‘raw materials become the new oil’. *Euractiv*. <https://www.euractiv.com/section/circular-economy/interview/eus-sefcovic-raw-materials-could-become-the-new-oil/>

³⁴ European Commission (n.d.). Internal Market, Industry, Entrepreneurship and SMEs. https://single-market-economy.ec.europa.eu/sectors/raw-materials/policy-and-strategy-raw-materials_en; European Commission. (2008). *Communication from the Commission to the European Parliament and the Council - The raw materials initiative: meeting our critical needs for growth and jobs in Europe* COM/2008/0699 final

³⁵ European Commission. (n.d.). Internal Market, Industry, Entrepreneurship and SMEs. https://single-market-economy.ec.europa.eu/sectors/raw-materials/policy-and-strategy-raw-materials/sustainable-supply-global-markets_en

³⁶ European Commission (n.d.). Internal Market, Industry, Entrepreneurship and SMEs. https://single-market-economy.ec.europa.eu/sectors/raw-materials/policy-and-strategy-raw-materials/sustainable-supply-raw-materials-eu-sources_en

³⁷ European Commission, (n.d.). Internal Market, Industry, Entrepreneurship and SMEs. https://single-market-economy.ec.europa.eu/sectors/raw-materials/policy-and-strategy-raw-materials/resource-efficiency-and-recycling_en

TACKLING THE RISK OF A FUTURE EU ENERGY CRISIS IN CRITICAL RAW MATERIALS?

by the creation of the *European Innovation Partnership on raw materials*,³⁸ which secured funding for research and innovation.³⁹

Moreover, in 2020, the European Commission announced the *Raw Material Action Plan* highlighting the relevance of developing a resilient value chain for the EU industrial environment, the importance of reducing dependency on primary CRMs through recycling and innovation, and the need to strengthen domestic sources of raw materials and diversifying imports from third countries while ensuring unhindered access to international markets, through concluding Free Trade Agreements, participating in international fora, and establishing strategic partnerships with resource-rich third countries.⁴⁰

For these purposes, the European Raw Material Alliance (ERMA) was established as a platform to facilitate collaboration among stakeholders, including industries, investors, researchers and innovators. The aim was to support activities and projects with the potential of securing a sustainable supply of fundamental raw materials.⁴¹ ERMA identified investment opportunities with projects across Europe for a total investment volume of €1.7 billion, which realisation has the potential to cover the 20% of Europe's rare earth magnet needs by 2030.⁴² A relevant project, announced in March 2022, entails ERMA supporting the Canadian Mkango Resources Ltd in developing a rare earth separation plant located in Puławy, Poland, to be supplied with rare earth carbonate from Malawi, Africa.⁴³

Moreover, attention was given to strengthening domestic sources and processing activities of raw materials within the EU.⁴⁴ Indeed, Europe has domestic potential reserves of REEs and some sites are considered economically viable as a by-product of the extraction of other minerals.⁴⁵ However, a number of constraints still restrict mining in Europe, including a lack of exploration and mining investment, complex and protracted national permitting processes⁴⁶ and public opposition based on environmental concerns. For instance, in 2017 a mining project of Quantum Minería has been blocked due to concerns about its negative impact on water resources and biodiversity and in 2021

³⁸ Euromines. (n.d.). *European Innovation Partnership on Raw Materials*. <https://www.euromines.org/what-we-do/european-innovation-partnership-raw-materials>

³⁹ European Commission. (n.d.). Internal Market, Industry, Entrepreneurship and SMEs. https://single-market-economy.ec.europa.eu/sectors/raw-materials/eip_en#:~:text=The%20European%20innovation%20partnership%20on,public%20services%2C%20academia%20and%20NGOs.

⁴⁰ European Commission. (2020). *Communication From The Commission To The European Parliament, The Council, The European Economic And Social Committee And The Committee Of The Regions Critical Raw Materials Resilience: Charting a Path towards greater Security and Sustainability* COM/2020/474 final. Brussels.

⁴¹ European Raw Materials Alliance. (2020). *Declaration of the European Raw Materials Alliance (ERMA)*. <https://www.erma.eu/app/uploads/2020/09/c31815ef.pdf>

⁴² Gauß, R., Burkhardt, C., Carencotte, F., Gasparon, M., Gutfleisch, O., Higgins, I., Karajić, M., Klossek, A., Mäkinen, M., Schäfer, B., Schindler, R., Veluri, B., (2021). European Raw Materials Alliance. (September 2021). *Rare Earth Magnets and Motors: A European Call for Action*. https://eit.europa.eu/sites/default/files/2021_09-24_ree_cluster_report2.pdf

⁴³ European Raw Materials Alliance. (n.d.). *Diversifying the rare earth value chain for Europe's green transition*. <https://erma.eu/diversifying-the-rare-earth-value-chain-for-europes-green-transition/>

⁴⁴ Ibidem.

⁴⁵ Goodenough, K.M., Schilling, J., Jonsson, E., Kalvig, P., Charles, N., Tuduri, J., Deady, E.A., Sadeghi, M., Schiellerup, H., Müller, A., Bertrand, G., Arvanitidis, N., Eliopoulos, D.G., Shaw, R.A., Thrane, K., Keulen, N., (2016). Europe's rare earth element resource potential: An overview of REE metallogenetic provinces and their geodynamic setting. *Ore Geology Reviews*. Volume 72. Part 1. Pages 838-856, <https://doi.org/10.1016/j.oregeorev.2015.09.019>; Eurare. (n.d.) Location of REE occurrences and deposits in Europe. <https://www.eurare.org/countires/reemap.html>;

⁴⁶ European Commission. (2020). *Communication From The Commission To The European Parliament, The Council, The European Economic And Social Committee And The Committee Of The Regions Critical Raw Materials Resilience: Charting a Path towards greater Security and Sustainability* COM/2020/474 final. Brussels.

TACKLING THE RISK OF A FUTURE EU ENERGY CRISIS IN CRITICAL RAW MATERIALS?

the company lodged a legal appeal which was rejected.⁴⁷ Another example is the case of Greenland Minerals. Since 2021 the company is facing obstacles concerning the Kvanefjeld rare earth elements project in Greenland, due to a national ban on uranium exploration and exploitation from which REEs would be extracted as a by-product.⁴⁸

It has to be noted that, projects to supply REEs were in place before the creation of ERMA. Already in 2018 the pilot project SecREEs (Secure European Critical Rare Earth Elements) aimed at ensuring a “secure supply of critical REEs based on sustainable extraction from European apatite sources used in fertiliser production”.⁴⁹ Initially the project received financial support from the European Union Horizon 2020 program and involved two Norwegian companies, Yara and REEtec, and the research institute SINTEF, then it grew into comprising partners from different countries in Europe (Norway, England, France, Switzerland, and Belgium).⁵⁰

Considering recycling, between 2015 and 2019 the project REE4EU worked to demonstrate the feasibility of recycling material to manufacture permanent magnets which have comparable properties with respect to those produced using virgin materials.⁵¹ The REPRODUCE project has the goal to establish a recycling value chain of REEs at an industrial scale. The project intends to offer the production of REEs by using environmentally friendly and socially sustainable technologies that are competitive with Chinese production.⁵²

Notwithstanding the fact that recycling REEs is a growing market and has the potential to cover the 25% of the market of rare earth magnets, this will take years, in particular considering the fact that the percentage of recycled rare earth magnets is low, around 5%⁵³ and that it takes from 2 to 5 years to install a major rare earth processing and recycling plant to manufacture magnets.⁵⁴

Despite the existence of (pilot) projects, initiatives and a plan of action, the EU and its member states still need to establish a secure supply chain of CRMs and more effort is needed to achieve this goal.

A further step was taken in September 2022, the European Commission announced the *Critical Raw Material Act* as a new legislative proposal to address the issue of dependence on Chinese raw materials and ensure a more secure supply chain. The Act specifies the necessity to concentrate on those CRMs that are deemed strategic for the green and digital transition, and for defence technologies. In addition, attention is given to creating a European network of raw material agencies

⁴⁷ Arce M., (2021) Tierras raras: el oro tecnológico que nos convierte en potencia mundial pero que García-Page no quiere tocar. *Libremercado*. <https://www.libremercado.com/2021-12-11/tierras-raras-campo-montiel-matamulas-nos-convierte-potencia-mundial-garcia-page-no-quiere-tocar-6844883/>

⁴⁸ World Nuclear News. (2022). Greenland Minerals seeks clarity on Kvanefjeld licence. <https://www.world-nuclear-news.org/Articles/Greenland-Minerals-seeks-clarity-on-Kvanefjeld-lic>

⁴⁹ SecREEs - Secure European Critical Rare Earth Elements. (n.d.). Objectives. <http://www.sintef.no/projectweb/secreets/objectives/>

⁵⁰ SecREEs - Secure European Critical Rare Earth Elements. (n.d.). Consortium. <http://www.sintef.no/projectweb/secreets/consortium/>

⁵¹ Sustainable Process Industry through Resource and Energy Efficiency. (n.d.). REE4EU project came to an end. <http://www.ree4eu.eu/overall-results/>

⁵² SINTEF (n.d.). SINTEF projects <https://www.sintef.no/en/projects/2022/reeproduce-dismantling-and-recycling-rare-earth-elements-from-end-of-life-products-for-the-european-green-transition/>

⁵³ Kinch, D. (2021) Recycling could account for 25% of rare earths market in 10 years: Mkango. S&P Global Commodity Insights. <https://www.spglobal.com/commodityinsights/en/market-insights/latest-news/metals/110321-recycling-could-account-for-25-of-rare-earths-market-in-10-years-mkango-ceo>

⁵⁴ Gauß, R., Burkhardt, C., Carencotte, F., Gasparon, M., Gutfleisch, O., Higgins, I., Karajić, M., Klossek, A., Mäkinen, M., Schäfer, B., Schindler, R., Veluri, B., (2021). *Rare Earth Magnets and Motors: A European Call for Action*. European Raw Materials Alliance. https://eit.europa.eu/sites/default/files/2021_09-24_ree_cluster_report2.pdf

to develop monitoring and stress testing capabilities in order to foresee risks of disruptions, price increases or shortages and take decisions accordingly. Additionally, it is considered important to strengthen the supply chain through supporting projects and attracting private investment along the whole value chain from mining to recycling. To facilitate and reduce the timing of project implementation it is proposed to identify Strategic Projects considered of European interest. Lastly, emphasis is placed on preserving a level playing field, in particular, stimulating strategic storage capacities for each Member State and promoting recycling and reuse of raw materials with free circulation of secondary raw materials.⁵⁵

Concerning international activities, in June 2022, it was announced the establishment of the Mineral Security Partnership between the European Commission and other ten partners Australia, Canada, Finland, France, Germany, Japan, the Republic of Korea, the United Kingdom, and the United States. The aim of this partnership is to support countries in exploiting their own geological endowments in order to secure the supply chain of critical minerals along the whole value chain (production, process, and recycling) while ensuring compliance with environmental, social, and governance standards.⁵⁶ This multinational partnership is an important step to try to balance Chinese predominance.

Recommendations

In a context in which the trajectory to a zero-emission economy and an increasing demand for CRMs, it is important for the EU to consider the risk of dependency on a single supplier. Indeed, the current energy crisis is an important lesson that a lower degree of diversification of suppliers can have a detrimental effect on economic stability and growth.

Considering that CRMs are used to sustain the green and digital transition, and are essential for defence and medical-related technologies and taking into account that a single country, China, is increasing its dominant role along the whole supply chain of critical raw materials, and in particular REEs, it is of utmost importance for the EU and its member states to secure the CRMs value chain through internal measures and foreign policy activities.

1. The EU and its member states should design a more secure value chain for CRMs through domestic development.

In order to have a more secure CRMs value chain there is the need to revitalise and in some cases establish from scratch an internal production of CRMs working on all the steps of the value chain. Member states can count on preexisting know-how, as well as on research activities and projects that industries and research institutions, among other actors, are willing to undertake. In addition, it is essential to promote cooperation among stakeholders by taking advantage of already existing tools to facilitate and encourage cooperation and have access to investment opportunities.

a. Expanding domestic mining and refining of CRMs

A number of constraints restrict mining in Europe. Therefore, it is important for the EU and its member states to use their financial instruments and capabilities to support investments in exploration and mining production, as well as it is necessary to tackle the issue of the currently

⁵⁵ European Commission (2022). *Critical Raw Materials Act: securing the new gas & oil at the heart of our economy* https://ec.europa.eu/commission/presscorner/detail/en/STATEMENT_22_5523

⁵⁶ US Department of State Minerals. (2022). *Security Partnership*. <http://www.state.gov/minerals-security-partnership/>

prolonged and complex procedures granting licences. In addition, it is necessary to address the public opposition to mining projects based on environmental and biodiversity concerns. All relevant stakeholders, for instance, local authorities and communities, need to be involved in the decision-making process, hence appropriate information is needed on the mining industry, including insurance on the application of the highest environmental, social and governance standards in its activities. Also, it should be conveyed the message that it is of utmost importance to undertake mining projects on European soil, for instance, underlining the relevance for the EU's security and economic growth, as well as underlying the fact that importing mining products from other countries might entail importing products that were extracted under lower environmental regulations (and human and labour rights) and that transporting on longer distances entails higher ecological footprint. Concerning this latter point, lower environmental footprint technologies for exploration and mining should be researched and applied, as is the case of the two passive seismic techniques for exploration activities developed by the team of the PACIFIC project.⁵⁷

Along with mining, it is needed to support the refining activities of the extracted products within Europe in order to maintain control of another step of the value chain and avoid exporting the product extracted in Europe to be refined abroad, as well as reducing the imports of refined products.

b. Recycling and reuse of critical raw materials

In order to reduce the demand for primary raw materials and the dependency on external suppliers a role is played by recycling and reuse of CRMs. It is important for the EU and its member states to increase investments in research and innovation to acquire technologies that can foster recycling and reuse while ensuring the quality of secondary raw materials. In addition, investments should support the projects in building up industrial-scale activities. Also, it is important to promote know-how sharing, while protecting intellectual rights.

Moreover, it is needed to address the issue of collecting the technological waste that has to be used to produce secondary raw materials. It is important to put in place controlled and efficient recycling activities as well as facilitate its circulation.

c. Potential of reprocessing mineral waste

The production of CRMs can be attained through reprocessing of mineral waste. Indeed, during the extraction and refining activities of ores mineral waste is generated, which can be processed in order to obtain other minerals. For instance, REEs, in particular scandium, could be obtained by the processing of the bauxite residue which is a by-product of the Bayer process.⁵⁸ The EU and its member states should stimulate research through the adoption of policies and financial support at the EU level and promote financing by private investors. Support is needed at the pilot stage of projects and for the industrial-scale build-up.

2. The EU should invest in and promote research on CRMs substitutes and alternative technologies

⁵⁷ CORDIS EU research results. (2022). *Passive seismic techniques for environmentally friendly and cost efficient mineral exploration*. <https://cordis.europa.eu/article/id/436268-finding-new-minerals-in-europe-using-environment-friendly-low-cost-technologies>

⁵⁸ Binnemans, K., Pontikes, Y., Jones, P., T., Van Gerven, T., Blanpain, B., (2013) Recovery of Rare Earths from Industrial Waste Residues: A Concise Review. Proceeding of the Third International Slag Valorisation Symposium. Leuven. <https://eurelco.org/2018/10/13/recovery-of-rare-earths-from-industrial-waste-residues/>

TACKLING THE RISK OF A FUTURE EU ENERGY CRISIS IN CRITICAL RAW MATERIALS?

Along with ensuring the supply of CRMs, the EU should promote research on potential substitutes of the CRMs currently used in applications related to the dual transition, and defence and medical-related technologies. In addition, support should be given to research conducted on technologies that do not need CRMs. This is relevant not only because of the need to reduce the demand for CRMs and the dependency on third countries' supplies but also in light of the fact that resources are not illimited and countries around the world are exploiting these resources as well.

3. The EU and its member states should design a more secure value chain for CRMs through international cooperation.

Along with internal development, the CRMs value chain has to be secured by strengthening relationships with third countries. The EU should accelerate the ratification of already existing agreements, for instance with Chile and Mexico,⁵⁹ and progress on ongoing negotiations with Australia which has CRMs and REEs potential, for instance.⁶⁰ Indeed, it is important to create and strengthen the bases to boost cooperation among the EU, its member states and their companies with third countries' partners. Moreover, it is relevant to engage with China. Given the predominant role of the country

Particular attention has to be given to developing partnerships and projects with African countries, which have significant potential as suppliers of CRMs. Notwithstanding the fact that China already ensured its companies' presence within the African continent in order to take advantage of the existing reserves, it has to be considered that Chinese companies' practices raised concerns about labour rights violations and human rights abuses, for instance concerning low wages, poor working and living conditions, and preferential treatment of Chinese workforce,⁶¹ which created frictions.

Therefore, the EU should build upon the already established relations with African countries and promote partnerships based on respect for human and labour rights, sustainable resource production, and support for local development. A case in point is the European Commission-founded project '*Building EU-Africa partnerships on sustainable raw materials supply chain*', known as AfricaMaVal, which aims at ensuring ethical mineral sourcing for European industry while supporting local development.⁶²

Along with activities related to the supply of primary raw materials, African countries can develop supplies of secondary raw materials from recycling electronic waste (e-waste), in particular Algeria, Egypt, Nigeria, and South Africa have a high production of e-waste and Egypt, Nigeria, and South Africa already have dedicated national regulations on e-waste.⁶³ This is an opportunity for the EU and its companies to cooperate with third countries to develop recycling projects that can contribute to the national needs of African countries as well as the European needs. Hence,

⁵⁹ MercoPress (2022). *Spain calls for a quick ratification of EU trade agreements with Chile, Mexico and Mercosur, but what else is needed?* <https://en.mercopress.com/2022/05/17/spain-calls-for-a-quick-ratification-of-eu-trade-agreements-with-chile-mexico-and-mercosur-but-what-else-is-needed>

⁶⁰ Earth sciences for Australia's futur. (n.d.). *Rare Earth Elements*. <https://www.ga.gov.au/scientific-topics/minerals/mineral-resources-and-advice/australian-resource-reviews/rare-earth-elements>; Page, M., Coyne J., (2021). Australia has a key role to play in reducing China's rare-earths dominance. *Australian Strategic Policy Institute*. <https://www.aspi.org.au/australia-has-a-key-role-to-play-in-reducing-chinas-rare-earths-dominance/>

⁶¹ Link, J., (2021). 5 Things U.S. Policymakers Must Understand About China-Africa Relations. *Americanprogress*. <https://www.americanprogress.org/article/5-things-u-s-policymakers-must-understand-china-africa-relations/>

⁶² World Resources Forum. (2022). WRFA partner of new Horizon Europe project developing EU-Africa partnerships for responsible sourcing of critical raw materials. <https://www.wrforum.org/projects/wrfa-partner-of-africa-maval/>

⁶³ JRC Digital Media Hub. (n.d.). Critical Raw Materials in Africa. European Commission. <https://visitors-centre.jrc.ec.europa.eu/en/media/tools/critical-raw-materials-africa>

TACKLING THE RISK OF A FUTURE EU ENERGY CRISIS IN CRITICAL RAW MATERIALS?

investments will be needed in order to establish these partnerships and support research on recycling.

Conclusion

This paper highlights the importance of CRMs, as stated by the European Commission Vice-President for Inter-institutional Relations and Foresight, Maroš Šefčovič, in the future the “demand for critical raw materials will only increase, especially given the ongoing transition to the green and digital economy”.⁶⁴ Indeed, CRMs are essential elements to be used in renewable energy technologies and environmentally friendly applications. Therefore, an interruption in their supply can have a detrimental effect on the EU energy system and its economy.

This paper considers the EU import dependency on external suppliers of CRMs, in particular, it is analysed the dominant role of China, which strategically positioned itself along the whole value chain of CRMs.

Therefore, it is underlined the risk of being dependent on a single major supplier and the detrimental effects of a future CRMs supply disruption. A relevant example is the dependency of the EU on one major supplier of fossil fuels, Russia, amidst the current energy crisis exacerbated by the war in Ukraine.

In this paper, the efforts put in place by the EU to tackle the issue of ensuring a safe CRMs supply are described. However, it has to be noted that a significant impact on the supply chain of these materials will take years, and there is still a need for further steps to ensure a secure supply chain for the EU to avoid future crises. The recommendations given in the paper focus on the efforts that the EU should put in place on the domestic dimension and in collaboration with other international actors, in particular potential suppliers. Additionally, efforts should focus on CRMs substitutes and alternative technologies.

⁶⁴ Simon, F., (2020). New EU alliance aims for ‘strategic autonomy’ on key raw materials. *Euractiv*. <https://www.euractiv.com/section/circular-economy/news/new-eu-alliance-aims-for-strategic-autonomy-on-key-raw-materials/>

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